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Empowering Teachers to become Change Agents through the Science Education In-Service Teacher Training Project in Zimbabwe
Habiller les enseignants à devenir des agents de changement à travers un projet de formation en service des enseignants en éducation des sciences, au Zimbabwe

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Abstract

This paper presents findings from a study of three Zimbabwean science teachers who participated in the Science Education In-service Teacher Training (SEITT) program. At the turn of the century, the SEITT program was designed to develop science and mathematics teachers into expert masters and resource teachers for Zimbabwe's ten school districts. The study investigated the successes and challenges faced by the three teachers who were in the process of reforming their pedagogical practices as well as writing and using contextualized science curriculum materials to teach secondary science. Data were collected through telephone interviews. The three teachers reported that the SEITT program helped them to transform their practice as well as that of their peers. They also reported that changing their teaching methods motivated learners to actively participate and this change also resulted in improved teacher efficacy. The paper discusses implications for improving science teaching and suggestions for contextualizing the science curriculum in developing countries.

Résumé

Cet article présente les résultats d'une étude concernant trois enseignants de science zimbabwéens qui ont participé au programme de formation en service des enseignants en éducation des sciences (FCEES). Au tournant du siècle, le programme FCEES a été conçu afin de former les professeurs de sciences et de mathématiques en maîtres experts et en enseignants-ressource pour les dix districts scolaires de Zimbabwe. Cette étude a examiné les succès et les défis rencontrés par les trois enseignants qui étaient en plein processus de réformer leurs pratiques pédagogiques ainsi que d'élaborer et d'utiliser des curriculums contextualisés de sciences pour enseigner les sciences au secondaire. Les données ont été recueillies à travers des entrevues téléphoniques. Les trois enseignants ont rapporté que le programme FCEES les a aidés à transformer leur pratique de même que celle de leur collègues. Ils ont également rapporté que changer leur méthodes d'enseignement a motivé leurs apprenants à participer activement, et ce changement a également contribué à augmenter leur efficacité en tant qu'enseignant. Cet article discute des implications visant à améliorer l'enseignement des sciences, et des recommandations pour contextualiser les programmes scolaires de sciences dans les pays en voie de développement.

Keywords: in-service teacher training, resource teachers, teacher efficacy, contextualized teaching and learning, science curriculum reform, teacher professional development, teacher identity

Mot-clés: formation en service des enseignants; enseignants-ressource; efficacité de l'enseignant; enseignement et apprentissage contextualisés; réforme des programmes scolaires de sciences; développement professionnel des enseignants; identité des enseignants.

Introduction

In the 1990s, Zimbabwe, received funding from international organizations to reform secondary science education, and 1995 saw the inception of the Science Education In-service Teacher Training (SEITT) project which was funded by the Dutch government (Johnston, 2000). The

SEITT project developed into a program in 1997 after the University of Zimbabwe established sustainability measures to ensure continuation of the program after donor funding had ended (Tambo et. al., 1999). SEITT was a professional development initiative that focused on improving the pedagogical skills of Advanced Level Science and Mathematics teachers. The program offered a two-year part-time in-service post-graduate diploma to secondary school teachers and its emphasis was on student-centred teaching and active learning strategies. Graduates from the SEITT program became resource teachers in their districts where they organized and facilitated content specific as well as pedagogical workshops for their colleagues (Tambo et. al., 1999; Mtetwa, 2003).

The SEITT professional development program used an integrated professional development model which utilized six intervention strands. These strands were integrated so as to take place simultaneously. The strands included: a) an integrated resource teacher training program, which was a fully accredited university postgraduate diploma course (Mushayikwa et. al. 1999); b) teacher networking and information technology (Mushayikwa, 2006); c) resource teacher workshops (Johnson, 2000); d) Science and Mathematics Resource Centers (Chavhunduka, 2005); e) Contextualized materials development (McKenney, 2001); and f) Peer coaching (Mtetwa, 2003). Some of the teachers who successfully completed the SEITT program went on to become resource teachers in the Science and Mathematics resource centers in their respective districts.

In 1999, the SEITT project applied for additional funding to assist the teachers (who had gone through the first SEITT phase) develop and implement contextualized science teaching resources. The process of writing contextualized curriculum materials involved the identification of everyday examples that could be used to demonstrate how particular science concepts may apply to the students' daily lives. The examples selected were those familiar to a majority of the students so that they can possibly realize how school science is related to some aspects of their daily lives. For example, most Zimbabwean families make drinks from fermented corn meal – that context would then be used to analyze the process as students learn science concepts related to fermentation. Teachers would then help students to build on their out-of-school experiences and knowledge to study industrial processes of fermentation. The contextualized materials-writing initiative eventually became part of the SEITT reform efforts in all the Zimbabwean school districts.

This report is part of a larger study, and several papers have been published chronicling the nature and process of the SEITT program as well as the self-directed teacher professional development model (Mushayikwa, 2013; Mushayikwa & Lubben, 2009; Mushayikwa, 2006; Mtetwa, 2003; Mushayikwa et al., 1999; Tambo et. al., 1999). The current paper addresses issues around the development of contextualized science teaching materials which were facilitated by teacher-directed professional development workshops, an important component of the SEITT intervention initiative. The study raises fundamental issues on teacher innovation, professional development and empowerment. This work is particularly significant because in Zimbabwe, issues of relating school science to learners' real life experiences are still a challenge for most teachers. The SEITT project is no longer in operation and currently there are no similar professional development efforts in Zimbabwe. The authors feel that the self-directed model of teacher professional development is sustainable and can be adopted by teacher education programs in Zimbabwe as well as by other developing countries. The teacher experiences described in this paper will provide useful insights to science teachers who continue to grapple with making school science meaningful to learners' experiences; hence we see the relevance of

this study to current debates and issues around science learning, contextualized pedagogy and teacher professional development especially in developing countries.

The main objective of this study was to gain some understanding of the successes and challenges faced by SEITT lead teachers in their efforts to implement contextualized science teaching strategies as well as running professional development workshops for their colleagues. The following research questions guided the study: a) how did the teachers perceive their professional identities and practice after participating in the SEITT program? b) How did the teachers perceive their professional identities and practice as expert contextualized materials developers and implementers? c) What challenges did the teachers face when working with their colleagues to develop contextualized teaching material?

Literature Review

Teacher Professional Development

Professional development plays a critical role in the development of the teacher's professional role. Research suggests that teacher quality is significantly and positively correlated with student attainment (Darling Hammond et al., 2005; Greenwald, Hedges & Laine, 1996; Rockoff, 2004). Investing in teacher learning has been made a priority by nations seeking to improve student success. Studies have shown that the highest-achieving countries on international measures such as PISA (Programme for International Student Assessment and TIMSS (Trends in International Mathematics and Science Study) have focused on teacher professional development both through pre-service and in-service training (Darling-Hammond et.al., 2010). Many developed countries have ensured teachers are well prepared professionals through development of extensive teacher education programs. In fact, there are different versions of professional development in different countries. In Israel for example, teachers continue to learn within a school context after obtaining their higher education teaching qualification and they are encouraged to take their own routes of professional development (Zuzovsky (2001). In Australia, a more interactive professional development approach is taken which involves all teachers, the schools and the professional development providers (Ling and Mackenzie 2001).

Similarly, developing countries are making efforts to foster professional development of teachers. However, unlike the developed countries that have different models of teacher professional development, teachers in most developing countries have limited opportunities to systematic professional development initiatives. In a study exploring professional development among English-language teachers in Syria and Pakistan, Dayoub and Bashiraddin (2013) found that although no specific teacher professional development routes existed in these countries, the teachers were self-directed and they learned from various in-service experiences. The researchers also noted that the school environment provided support and opportunities for in-service learning and the teachers also got support from home. Similarly, Mushaikwa and Lubben (2009) reported self-direction as a potential key to professional development of teachers in developing countries, especially in deprived environments where there is no systematic teacher professional development. They defined self-directed professional development as a process of self-empowerment which is driven by social, psychological and professional needs and is thus intrinsically motivated.

Science Education in developing countries

At the 6th Southern African Association for Research in Mathematics, Science and Technology Education annual conference held at the University of Zimbabwe in 1999, Southern African

science educators unanimously agreed that science was being taught out of context. This was viewed as one of the reasons why Africa has been failing to produce the critical mass of scientists needed to keep abreast with technological and industrial developments that are taking place elsewhere. The phrase ‘contextualized science instruction’ in this paper is used to refer to science instruction that draws from relevant indigenous and everyday knowledge, and experiences that the learners bring to the classroom. Contextualizing science education has therefore pre-occupied science educators’ efforts in the Southern African region since then (Ogunniyi, 2007; Onwu et. al., 2006; Mushayikwa & Lubben, 2009).

A majority of teacher education programs in Southern Africa have not equipped science teachers with the necessary knowledge that would enable them to teach science in context through tapping on students’ out-of-school experiences. In addition, the school science curriculum materials such as science textbooks that were used in Southern Africa were written using examples and principles remote from a majority of the students’ lived or contextual experiences. The teachers who had limited skills on contextualizing their science teaching also lacked resources that would enable them to create such learning environments. There has been a great need to reform science teaching and to contextualize science curriculum material in order to make science accessible and relevant to learners in Southern Africa in general and Zimbabwean students in particular. The SEITT project in Zimbabwe was and still is one of the teacher professional development initiatives designed to equip teachers with contextualized materials writing and implementation skills.

The issues raised in this paper address some of the aspects pertaining to science education in developing nations in general and Zimbabwe in particular. These aspects include issues of teaching science to students whose cultural world-views are different than those of the Western-based “scientific” worldviews that are predominant in science curriculum materials. Thus students from non-western backgrounds need to adapt and accommodate both worldviews if successful learning is to take place. Teachers in developing countries are best placed to contextualize scientific knowledge within their localities. Mushayikwa (2006) argues that effective science teachers are those who have well developed pedagogical content knowledge (PCK) (Shulman, 1987). Veal & Mackinster, (1999) have developed PCK taxonomies that establish the link between PCK and effective teaching. This link is best demonstrated when teachers develop their own contextualized teaching materials using their knowledge of the subject, students, appropriate pedagogy and the context in which they are operating.

Contextualizing science education

Contextualism is a Deweyan or idea-based social constructivism, which accepts the fact that understandings emerge at the boundary of the person and the environment, are situated in context and might change as context changes over time (Prawat & Floden, 1994). When applied to science learning, contextualism entails using examples and applications of science that are familiar to students. The teacher’s role in this case is to help students make connections between their lives and the world of science. When taught this way science becomes meaningful to the student. This way of thinking about science teaching is based on the understanding that science is a social activity, and that scientific knowledge is socially constructed (Lemke, 2001).

The contextual constructivist framework for science teaching is in agreement with Ausubel’s (1978) description of meaningful learning. According to Ausubel (1978), meaningful learning occurs when students make connections between new knowledge and what they already know. Sjøberg and Schreiner (2005) argue that fewer college and university students choose to

specialize in science, or to pursue science-related careers because they have experienced school science as an alienating subject. Alienating in the sense that the language used in science is different than the everyday language. As a result of this alienation, some students may not realize how school science is relevant to their lives; hence science is viewed as a difficult subject. Aikenhead (2006) argued that science curricula fail to capture the imagination of learners mainly because of the lack of relevance or meaning to the learners' contexts. Lemke (1990) further claims that science as a subject is not readily accessible to students because of its abstract nature and technical language, which is different from everyday language.

Mushayikwa and Lubben (2009) argued that engaging science teachers in contextualized materials development is a necessary component of self-directed professional development, as it enables teachers to tackle challenges relating to both their classroom and professional efficacy needs. For example, in their study they noticed that successful contextualization resulted in more confidence, greater authority and leadership (professional efficacy) and also deeper content knowledge, greater adaptation of content and more creative use of resources (classroom efficacy). These two efficacies therefore were used as lenses to answer the following three questions that guided this study: a) how did the teachers perceive their professional identities and practice after participating in the SEITT program? b) How did the teachers perceive their professional identities and practice as expert contextualized materials developers and implementers? and c) what challenges did the teachers face in developing contextualized teaching materials?

Research Methods

This study was designed to gain some understanding of the success and challenges faced by some SEITT resources teachers who were involved in developing and implementing contextualized science materials as well as providing support to their colleagues. Data were collected through telephone interviews with three science teachers in Zimbabwe. Purposive sampling using predetermined criteria (Patton, 1992; Cutcliffe, 2000) was used in this study. The underlying assumption of the sampling strategy was that participants would provide the most comprehensive understanding of the phenomenon under study.

Teachers who were interviewed for this study were selected from a pool of teachers who had responded to previous SEITT surveys that were sent to 200 teachers who had participated in the Science Education In-service Teacher Training (SEITT) program. From these surveys, six SEITT graduates who had participated in the contextualized materials writing workshops were initially invited to participate in the study. Out of the six teachers, three responded and were willing to participate in the study. These teachers were selected because they were easily accessible by telephone and by e-mail and they were teaching in three different districts. We therefore acknowledge the fact that the teachers who participated in this study may not necessarily represent all the teachers who participated in the SEITT professional development initiative- which is one of the limitations of this study. Participants' backgrounds are provided below under the pseudonyms Anthony, Boniface and Casper. These three are Zimbabwean teachers who held Licentiate teaching certificates from Cuba and they all had twelve years of high school teaching experience at the time of data collection.

Participants' Background

Anthony is a Chemistry and Physics teacher in north-eastern part of Zimbabwe. Anthony told us that he chose the teaching profession because he felt that he had a duty to inspire young people and to make an impact on their lives. His favorite subject in school was science which he learned

through memorization. When he started teaching, Anthony felt well-prepared for the job and he also got support from the principal. He credited his preparedness to his training in Cuba where he got lots of practical experiences and was exposed to student-centred learning models which were different from his learning experiences when he was a student in Zimbabwe.

Boniface is a Chemistry teacher in the central part of Zimbabwe. Although he liked Chemistry in high school mostly because it was taught in smaller groups, he had no intention of becoming a teacher. He had wanted to be an engineer or computer scientist. Boniface was motivated to participate in the SEITT program by the fact that he was finding it difficult to implement student-centred teaching in large classrooms and he was hoping the program would help him find solutions.

Casper is a Chemistry teacher in the western part of Zimbabwe. Casper was motivated to pursue science in high school by his math and physics teacher who made the subjects meaningful by exploring the history and how the content occurs in real life. He recalled his learning in Cuba that was more experiential; including visits to industries and became familiar with real-life examples of some industrial chemical processes. When he started teaching in Zimbabwe, he realized that some students were not doing their homework and were not actively engaged in school. When Casper learned about the SEITT program that was offered at the University of Zimbabwe, he joined believing that it would give him the opportunity to reach out to the students.

Data Sources and Analysis

Data for this study were collected through telephone interviews with the three teachers. A semi-structured biographical interview protocol was used to gain understanding on the following: a) teachers' self-reported experiences as learners b) their teaching experiences before and after the in-service training, c) teachers' experiences in contextualizing their science curriculum and d) challenges they confronted in reforming their own teaching and that of their colleagues in the districts where they worked. The interviews were audio-recorded and transcribed verbatim. The researchers read and re-read the scripts to find some emerging themes. Field notes that were recorded during interviews were used to expand on data analysis. To determine similarities and differences among the interviewees, biographical data was also collected as part of the interview protocol.

Discourse analysis was used in an effort to make meaning of the interview transcripts. We used Frohmann's (1994) view of discourse analysis that entails contextual deconstructive and interpretative reading of text. The first and third author read and re-read the transcripts to identify emerging themes. Integrator reliability of the discourse analysis was ensured by having all the authors checking the consistence of theme identification. In line with Glaser and Strauss' (1967), thematic coding and re-reading the text was used to identify themes and to establish relationships between the themes.

Findings

We are aware that the sample size in this study limits the extent to which the findings can be generalized. However, the in-depth data analysis enabled us to capture some of the successes and challenges faced by the teachers who graduated from the SEITT program. From the data analysis, the following six themes were identified: a) The SEIT program helped teachers to change the way they think about students and teaching; b) Student-centred teaching approaches resulted in student motivation; c) Teachers used contextualized teaching materials successfully; d) Contextualizing science content promoted understanding; e) Teachers as leaders; f) Challenges

faced by the teachers. Each of the themes is described below with supporting evidence from the interview transcripts.

Theme 1: The SEIT program helped teachers to change the way they think about students and teaching. The teachers in this study reported that participation in the SEITT program affected the way they now think about their pedagogical practices and the way they interact with students. All three teachers reported that their own experiences learning science had influenced the way they initially thought about teaching. Boniface articulated how his relationship with students changed as a result of participating in the SEITT program:

Most teachers just work with students who want to learn, the ones who don't want to learn are left alone. ... When I went to school, learning was generally through the stick, you simply had to do it. Learning did not depend on how the teacher taught you but you had to learn it yourself. The teacher used lecture methods, there was very little participation and at times we were afraid to ask when we did not understand. You had to go and read on your own. Students were passive receivers. The teacher just went to the board, worked on a problem and said “Ndarova vapfanha” literally meaning, “I did it”. The relationship between the students and myself has improved. I now realize I can learn from the students. Long back it was the teacher who had the knowledge.

Boniface shows how some teachers still view teaching as the responsibility of the students. He recounted how his own teacher would praise himself for managing to complete a problem on the board without paying attention to whether students understood or not and how learning was forced on students through corporal punishment. He also shows how his thinking changed and how he now views students as knowers.

The three teachers also reported that, as a result of the in-service training, they became aware of the fact that it is possible to change their pedagogical practices. These sentiments were mirrored in the following comments from Anthony:

Some students do not do their work because they do not understand what they are supposed to do. Talk to the students on a one on one basis and you see change. The moment I changed my teaching I realized that most of my students do their homework because when they come to class we talk about the homework and every student has to say something.

These examples show the changes in thinking and pedagogy that the teachers experienced as a result of participating in the in-service program. Their experiences as students in teacher-centered learning environments had shaped their initial teaching practices. Boniface for example, came to realize that students were not blank slates to be filled with knowledge, but that they brought some rich experiences from which the teacher could learn.

Theme 2: Student-centred approaches resulted in student motivation. The three teachers interviewed described their experience with the SEITT program as professionally enriching, saying that it equipped them with teaching and knowledge creation tools they needed. They mentioned that it was easier to go and try out the new methods of teaching because the SEITT instructors modeled student-centred teaching strategies that they wanted teachers to go and use. Casper articulated the changes that happened as result of using student-centred teaching methods in the following way:

I now see that if these students have to learn I have to employ different methods from the ones I learned e.g. student-centred activities and making students more active learners. I read someone who said, “A classroom that is not noisy has no learning going on.” I try and make them talk, go to the board, demonstrate etc. A student will never forget something he/she does e.g. carry out an

experiment or works a problem on the board, but forgets most of what they are told. I see myself as different from other teachers, however all teachers know these methods but implementation depends on the teacher.

This shows how participation in the in-service program enabled the teachers to implement student-centred teaching strategies that other teachers were not using even though they knew about them. It looks as if the SEITT professional development modelled examples that teachers were able to use in their own classrooms.

In addition, the participants reported that they have observed that students became more interested in science when they contextualized the science content. For example, Boniface said, "When I meet my students outside class they talk of certain lessons that they have done and this shows me that students are having an enduring understanding and are getting interested in physics." Casper argued evidence that even low-ability students were motivated to learn the same way as high-ability students.

Theme 3: Teachers used contextualized teaching materials successfully. All three teachers reported that they used contextualized science teaching strategies successfully. They showed that they were familiar with the local contexts that they could easily integrate into their science curriculum. Anthony clearly articulated an example of the local contexts he used when teaching about waves:

One of my favorite contexts when introducing the concept of waves to students is to ask kids if they have ever gone fishing. I would start by saying "Imagine you have gone fishing with grandfather and as grandpa waits patiently for a fish to come by, you throw a stone into the water." I ask students to describe what they see happening to the water and the floater on the fishing line. I then use the students' responses to introduce to them that the movement of the water and the floater moving up and down is because you have created a wave. I go on to tell them that the movement they see is not due to movement of molecules but its energy being transmitted.

Anthony also mentioned that their school did not have a ripple tank so they could not conduct experiments on waves. He reported that using a familiar example helped students to visualize the waves they have seen and they could make a connection between real life and the science concepts. Below is another example Boniface used to contextualize chemical reactions:

One example of a topic I have contextualized is about the rates of chemical reaction using ripening fruits, milk going bad and burning paper. I ask students to describe these processes and how long they take. Then introduce the concepts of chemical and physical reactions as well as reversible and irreversible reactions; the fact that once a fruit is ripened it will not be unripe and that a burned paper cannot change back. I also use examples of dissolving substances in water and how we can get back the sugar by drying up the water.

Boniface mentioned that this is different from the way chemical reactions are presented in science textbooks where only chemical names are used and chemical reactions are shown using symbols and arrows. He also added that examples used in textbooks normally refer to industrial or commercial processes that students may never encounter in their lives. The next example from an interview with Casper shows how he has been contextualizing his chemistry experiments:

I have successfully used soil from an anthill to run chemistry titrations. Since this soil is rich in iron, it replaces the chemical FeII (bought by the school) and hence cuts on lab costs. This has become a favorite with students as they watch the change in color showing that iron is present in

the soil. I have also successfully extracted some flower colors that I use as indicators in the chemistry labs

In a country where resources are scarce, Casper showed how he contextualized chemistry experiments by utilizing materials found in the local environment. Not only did Casper solve the problem of getting resources for his chemistry laboratory; he also showed students that minerals do not only exist in the laboratory but that they are a part of our environment, thus making laboratory chemistry an integral part of the student's everyday life. Casper also talked about how he wrote chemistry laboratory modules that are contextualized and could be used by other teachers:

I have produced a module on designing "A" level chemistry practicals. I contextualized the practicals and tried to simplify the information so that students can easily follow the instructions and assimilate the knowledge. I have the concentrations of chemicals specified, safety procedures, the questions, marking scheme on accuracy and sources of errors etc. Both students and teachers can use these both (modules and supplementary resources). Most teachers who have these modules are using them for their classes. Teachers as far as Chinhoi, Matabeleland and other places like to use the copy, it is easy to use for students as well as for teachers. Even students want to buy the book because they do not have such books in the country.

Inspired by Casper's contextualized chemistry laboratory manual, Anthony also wrote a contextualized physics laboratory manual that he planned to publish at the time we interviewed him:

I am planning to publish a book on contextualized physics practicals. I was given the incentive by one of the resource teachers from a school in Masvingo who wrote some modules for practicals in chemistry. He has now produced two volumes. I was shown the book by the Better Schools program coordinator when I visited the province and I was encouraged to do the same. I have been encouraging others to do the same and I hope his book will provide some tangible example to my colleagues. As a region we have writers' groups in Physics, Chemistry, Math and Biology.

Casper mentioned that he had always wanted to write his own teaching materials after he saw Cuban teachers write their own laboratory manuals. However, when he returned to Zimbabwe he was overwhelmed by teaching large classes and he taught mainly through lectures. He developed the practicals together with teachers from the province where he worked. Casper mentioned that he held workshops with other teachers where they came up with challenging practicals in chemistry then suggested ways to contextualize them. Casper then wrote up the practicals and tried them out with his students before he wrote the module.

Theme 4: Contextualizing science content promoted understanding. The teachers reported that using local examples familiar to students promoted understanding and helped to address misconceptions that normally come from a disconnection between the way students perceive the natural world and how science explains principles of nature. Boniface articulated the power of the contextualized teaching this way:

The contextualized method of teaching really worked because the students themselves have seen the change. Performance has improved and the syllabus is still completed. This way we are trying to remove some misconceptions. We have identified some misconceptions and we have come up with a way of getting rid of these misconceptions. Students have developed a positive attitude towards the subject.

In agreement with Boniface, Anthony also said:

The program introduced to us a way of making science "relevant, convenient and user friendly" to the students. This was done through writing contextualized teaching materials where local examples that are familiar to students are used as a central part of learning science concepts. "We bring the science knowledge close to the student. The student is able to understand the practicality of certain concepts that used to be theoretical and abstract.

The teachers also mentioned that contextualizing science helped to demystify science as a difficult subject and making it more accessible to all students.

Theme 5: Teachers as leaders. The teachers in this study reported that they were resource center managers at the time we interviewed them. In addition to their teaching responsibilities, they were in charge of the Science and Math centers for their districts and their responsibilities included networking with other teachers and running in-service workshops. At these workshops they identified problem areas in science teaching, shared ideas, and collectively came up with solutions for effective teaching. Anthony described his responsibilities and experiences as a resource teacher this way:

I hold workshops for teachers in the province. I have action plans for workshops scheduled for this year. We failed to start in January because I was doing syllabus interpretations and contributions from schools had not come yet. We have new syllabuses for science and mathematics and we want people to bring ideas on how they understand the syllabus; what is it they like and what is lacking, how best topics can be arranged so that it is logical. The syllabuses started in 2002. Our program is "Needs driven"; we invite education officers, send copies to SEITT and national head office; it is up to them to take it up.

The three teachers reported that they conducted materials writing workshops and other professional development workshops in their provinces to support their colleagues in their practice. Casper for example, was happy with the success rate of attendance at the workshops and how teachers in his district were benefiting from the workshops. Here is how he expressed his experiences working with teachers and developing science experiment modules:

So far we have managed to hold one workshop per term. I prepare questionnaires and during the workshop teachers identify problems and we try to solve the problem. I then put together all the solutions, test run the experiments and this is how I came up with the module. I take back the report to the teachers who give their feedback. The teachers are not participating fully because they say they don't have time. I did some of the experiments with my students. Teachers are benefiting from the workshops and the modules that have been produced. We have 34 high schools in our province and our workshops are very successful. More than 90% of schools attended workshops.

Anthony noted that the program in their province was needs driven, meaning that the agenda for their workshops depended on the teachers' needs. The teachers also reported that the support they got from the Ministry of Education and from the schools enabled them to successfully network with their colleagues.

Theme 6: Challenges faced by the teachers. Although these teachers reported success in changing their own pedagogical practices and in supporting their colleagues to some extent, they reported that they did face challenges and impediments to implementing these changes. The challenges they faced ranged from a) unwillingness by some colleagues to participate in the change process;

b) lack of resources for materials writing and supporting students' learning; and c) systemic policy issues such as the national curriculum and examinations that did not support contextualized teaching. Below, Boniface showed how Zimbabwe's declining economy significantly constrained the efforts that these teachers had made:

SEITT trained teachers are having different experiences depending on where they are located. Some resource teachers don't even attend the workshops or seminars maybe due to distances involved or they got tired of it. Looks like some have given up or they went back to their old way of doing things. However the economic situation could be having an impact on teacher motivation; no one wants to work for nothing. One big problem in teaching is that we are commended for immediate results in terms of grades that students get and not what they become. Good methods may not necessarily bring good grades and drilling could bring good grades but not understanding.

At the time we conducted this study, Zimbabwe was going through an economic crisis which greatly affected teachers because of lack of resources and financial support. This had a negative impact on the self-sustaining professional development model that had been instituted by the SEITT program. One of the interviewees, Anthony, pointed to lack of resources as a constraint to producing contextualized materials:

The challenge is how to produce the contextualized materials for use by the students due to lack of resources. The idea is noble and practical and I have seen it working to demystify science and mathematics. I have not written a lot of materials. Other teachers have also failed to do so.

Boniface also reiterated lack of resources ranging from laboratory equipment to books as constraining the teaching of science:

Science is a subject that has to be learned practically not theoretically therefore there is need to equip schools with the necessary equipment. There is need for introduction of information technology (IT) in the schools. Most of the physics concepts can be demonstrated through use of computer models. Students can also share ideas with other students on the Internet. There is also need for teachers to have access to IT as a teaching resource and aid. Some teachers have no idea how to use computers. There is a shortage of reading materials. There is need to equip school libraries.

In addition, the teachers highlighted their concern about the national examinations that were not aligned to the contextualized materials. Casper, for example showed how the contextualized materials he wrote were different than the questions that students were asked on the examinations:

Although the practicals I have written are popular and in use, they do not match very closely with the examination practicals that students have to be familiar with.... There is need to change the syllabus in order to cater for the changes. What I have tried to do is provide the exam-related experiments as an alternative example that students should know and make it explicit that this is what the exam will ask for and how it relates to the contextualized practical. I show them where I have substituted chemicals.

The teacher experiences above highlight some of the challenges faced by the teachers in their efforts to accomplish the goals of writing contextualized teaching materials and disseminating reform-based teaching ideas. They expressed frustration at the lack of resources and they worried about sustainability of the in-service program. Lack of motivation on the part of the other teachers was also a cause for concern for these teachers. Mobility of teachers as well

was a cause for concern because they felt it could lead to some centers not having resource managers and they would eventually close.

Discussion

The teacher testimonies in this study show how they perceived themselves to have changed the ways they think about teaching, learning, and the science curriculum as a result of participation in the Science Education In-service Teacher Training SEITT program. The SEITT program engaged science and Mathematics teachers in reform-based science teaching strategies and it also provided contextualized teaching workshops. The teachers reported to have reformed their teaching from a teacher-centred to a student-centred approach. Furthermore, they also reported to have changed their views of learning as the sole responsibility of the students to viewing the teacher as having the responsibility of making sure that students understand the science concepts. The SEITT program helped these teachers change the way they thought about teaching, the teacher's responsibilities, making science relevant to learners and motivating learners. Changing teacher practice has been shown to be complex, and according to Bell and Gilbert (1996) it is important to have long-term professional development that helps teachers change and reconstruct their role as science educators.

The SEITT professional development initiative was structured in such a way that it enabled these teachers to go back to their classes to practice and reflect on the techniques they learned (Bell & Gilbert, 1996; Flick *et. al.*, 1997; Mushayikwa *et. al.*, 1999). The SEITT program instructors modeled the new methods of teaching and it was easy for teachers to go and practice in their own classrooms. This program strengthened the teachers' pedagogical content knowledge which is critical for teaching (Grossman, *et. al.*, 2005; Shulman, 1987) and it enabled them to use the science curriculum flexibly to benefit the students. Teachers need good knowledge of pedagogy, content, and knowledge of students in order for them to do their job well (Shulman, 1987; Gess-Newsome & Lederman, 1999).

The teachers in this study became aware of the difference between their own in-depth science content understanding and the naïve content understanding among their students, and they realized how contextualizing science content helped to demystify science as a difficult subject. According to Upadhyay (2006), teachers who utilize students' lived experiences may be able to help linguistically and culturally diverse learners to learn meaningful science. In this case, although the students and teachers shared the same language and culture, they all come from a culture different from the Western culture on which the school science knowledge is constructed (Lemke, 1990). Costa (1995) showed how students are normally left to make connections between science concepts and their applications to the real world on their own; hence they find science alienating. In this study, we argue that contextualization might help students to make connections between out of school experiences and school science.

The SEITT model which equipped teachers with tools and knowledge to contextualize their teaching enabled the teachers to exercise agency (Vongalis-Maclow, 2005); going beyond merely using examples of local contexts in their teaching, but they also wrote contextualized science laboratory manuals that incorporated local contexts and materials. Agency as defined by Archer (1984) is composed of the three interconnected aspects; namely, obligation, authority and autonomy. What was critical in helping these teachers exercise their agency was the autonomy that they had to contextualize teaching in their classrooms as well as helping their colleagues do the same after they attended the materials writing workshops. The teachers felt empowered and viewed themselves as capable of developing contextualized teaching materials that other teachers

could use. This model of in-service teacher development enabled them to implement new teaching strategies and adapt their instruction to their students' needs while building a community of change in their school and districts (Fullan & Stiegelbauer, 1991; Joyce & Showers, 1988; Thiessen, 1992). The teachers were also motivated by the way their ideas were valued right from the inception of the program something that gave them the confidence to go back and change their teaching.

One way to bring about effective professional development in teaching is to make teachers the owners of the program as well as decision-makers in how to run their programs. However, it takes a lot of intrinsic motivation and dedication that is shown by the teachers in this study. One plausible explanation for the intrinsic motivation shown by these three teachers is the fact that they were all internationally trained in Cuba. They found their teacher training programs to be constructivist in nature and they described the frustration they experienced when they started teaching in Zimbabwe where traditional modes of instruction were common. The experiences of these three teachers are therefore not representative of all the teachers that went through the SEITT program. The teachers highlighted the challenges they faced and some impediments to the continuation of SEITT instituted professional development model. Not all teachers are willing to embrace reform efforts of any kind and there are some teachers who find it easier to change their practices than others are. In developing countries, this problem of program sustainability is worsened by lack of resources to fund the reform efforts after the donor funding runs out. This study shows that the SEITT model can be successful and self-sustaining as long as teachers get the financial support and resources.

Conclusion

This study demonstrates the importance of incorporating elements of self-direction in pre-service teacher training, as a means of developing teachers who are able to surmount the challenges of contextualization of curriculum materials as described in this paper. The study corroborates a growing body of research evidence which seems to suggest that if science concepts are directly linked to the daily lives of students, they will find it easier to use scientific concepts to explain the patterns they experience in everyday phenomena (see Beyer et. al., 2009; Daloglu, 2004; Kapyla et. al., 2009; Supovitz & Turner, 2000). As seen from this study, if teachers are empowered by involving them in the process reforming their own pedagogy and science curricula, they can become change agents in the field of science education. From this study we can conclude that if Zimbabwean teachers are empowered by involving them in the process of reforming their own pedagogy and the curriculum, they become owners of the reform, and the reform is more likely to be successful and sustainable.

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